-- Fig. 1 shows a schematic for the quantum dot laser diode portion of the QD-TEC laser in accordance with the invention. Such a diode comprises multiple layers of semiconductor materials which are depicted in the upper part of fig. 1, together with the corresponding energy band diagram shown in the lower part of fig. 1. In the band diagram, the vertical direction represents the energy of the carriers in the structure, and the horizontal direction represents the position of the carriers within the laser structure. The quantum dot layers 10, 14 are very thin; for instance in a preferred form of the device, the thickness of a quantum dot 72, 73 together with the wetting layer71, 70 which forms below the quantum dots 72, 73 is about 4.5 nanometers or smaller. Hence, it is necessary to provide a substrate to grow the layers and to give structural integrity to the device. The substrate can be electrically conducting or insulating, and will typically have a thickness between 0.1 and 1 mm. The substrate will preferably be covered with a buffer layer which also serves to initiate proper growth conditions during the epitaxy. --

C1

Please replace the paragraph commencing at line 23, page 9 by the following paragraph:

-- In particular, the amount of semiconductor material required to form the self-assembled quantum dots (72, 73, etc.) depends on the relative strain between the substrate and the quantum dots. The number of quantum dots per unit area can be adjusted by varying the amount of material deposited in the quantum dot layers. The size of the quantum dots can be adjusted from the substrate temperature used during the growth of each quantum dot layers. For example, in the exemplary embodiment, due to the small size of the quantum dots, quantum mechanics will dictate the values of energy levels (30, 32, 34, 36, 38, 50, 52, 54, 56, 58) localized in the low band gap material (68) by the barriers (9, 12, 15). The shape of the zero-dimensional potential gives rise to a series of discrete, atomic-like, energy levels for the electrons s_e, p_e, d_e, f_e, g_e (30, 32, 34, 36, 38 respectively), and for the holes s_h, p_h, d_h, f_h, g_h (50, 52, 54, 56, 58 respectively), below the wetting layer subband WL_e (40) and WL_h (60) for the electrons and holes respectively. For self-assembled quantum dots, the degeneracy of these levels is typically 2n where n is the index of the level with, n= 1 for the ground state S, n= 2 for the first excited state P, etc. where the factor of 2 comes from the spin degeneracy, and the factor n originates from the various allowed angular momentum. The self-assembled quantum dots effectively give a zero-dimensional potential with a quasi-parabolic confinement, and consequently the energy

C2

cont'd C2

spacing between the adjacent levels (also called the intersublevel spacing) is roughly constant for the various levels. --

Please replace the paragraph commencing at line 11, page 10 by the following paragraph:

C3

-- The number of allowed energy levels and intersublevel spacing is determined by the shape and size of the quantum dot, the height of the confining potential between the barriers (9, 12, 15) and the quantum dot layers (10, 14), and by the carrier effective mass. Experimental assessment of these energy levels can be obtained independently by probing the interband transitions and observing the state filling in photoluminescence or electroluminescence. The carriers introduced by the carrier injection fill the quantum dot energy levels in accordance with the level degeneracy, a rule similar to the atomic Hund's rule for filling orbitals, and Coulomb interaction and renormalization energies. For example, first the ground states s_e (30) or s_h (50) can each accommodate 2 carriers, one spin up, and one spin down, then the first excited states p_e (32) or p_h (52) can accommodate 4 carriers 2 spin up and 2 spin down, etc. The total number of available states is therefore given by the number of states per QDs for the energy range of interest, taking into account the degeneracy of the levels, multiplied by the density of QD in the layers which can be varied between 10^8 to 10^{10} cm^{-2}. This is typically about 2 orders of magnitude lower than for 2-dimensional quantum well structures, and therefore it is possible to saturate the states over a much wider energy range for the quantum dot laser diode.--

Please replace the paragraph commencing at line 1, page 13 by the following paragraph:

C4

-- Fig. 2 illustrates an example of how an external cavity and a wavelength-selective element can be configured to tune the output wavelength of the QD-TEC laser. The quantum dot laser diode 86 is aligned between reflectors 30 and 32, the wavelength-selective element 34 discriminate the optical path of the various wavelengths. Optical elements 86, 38 can also be used to determine the beam path outside the laser diode cavity 40, and to initiate the waveguiding inside the laser diode cavity 40. Several configurations are possible, but fig. 2 exemplifies one of the possible embodiments using a diffraction grating for the wavelength-selective element 34. For such an embodiment, the optical element 86, 38 will preferably be lenses used to provide the desired optical characteristic and mode profiling functions, and to collimate the photons existing the laser diode. One

side of the collimated beam 44 is incident on the diffraction grating 34 and at an angle θ The grating then disperses the light mainly in a preferred intensity ratio between a zero-order diffraction 46 and a first-order diffraction 48. The wavelength in the zero-order diffraction are not dispersed and this beam 46 can be used as the (or one of the) output beam of the QD-TEC laser. The wavelengths in the first order beam 48 are dispersed in space and a spatial filter 50 can be used to let only the desired wavelengths resonate in the cavity. The wavelength tuning can be achieved by turning the grating angle θ or preferably by displacing the spatial filter 50, either of which will vary the wavelength bandpass which is allow to resonate in the cavity. The adjustment of the tuning element can be made with the help of some mechanical components or some electro-optical actuating devices which can be calibrated and/or computerized. --

Cont'd C4

Please replace the paragraph commencing at line 9, page 14 by the following paragraph:

-- Also as mentioned above, fig. 2 exemplifies one of the many possible embodiments, and for example in some embodiments, it might be preferable to build the wavelength-selective tuning element integrated to the QD laser diode by using lithography techniques to produce gratings directly on the semiconductor, and which could be tuned using electric fields and/or currents in part of the device. Also, in some embodiments, it might be preferable to build part of the external cavity integrated to the QD laser diode and/or to the wavelength selective tuning element. For example, the reflector 30 and the optical element 86 are preferably eliminated by producing a reflector with the appropriate optical properties directly on the laser diode facet 64 using a combination of deposited thin films. Similarly the optical properties of the facet 62 can be adjusted by depositing thin films to optimize the device performance. Also the reflector 32 can be eliminated by folding the first order beam 48 directly back on the laser diode beam 66. The preferred geometry and the optical properties of the various elements will be dependent of the desired tuning range and power, and the desired spatial, temporal, and spectral mode profile for the QD-TEC laser. For example, the reflectivity and the transmission spectra of the reflector 30 and 32, and/or of the facet 60 and 62, as well as the grazing angle of the grating 34, will have to be adjusted according to the wavelength range of the QD-TEC laser. --

C5

Please replace the paragraph commencing at line 26, page 14 by the following paragraph: